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Monetary and Fiscal Policy Design in the EMU: An Overview

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Abstract

The interaction of monetary and fiscal policies is a crucial issue in a highly integrated economic area as the European Union. This paper analyzes the design of monetary and fiscal policies in the EMU. To do so, the paper starts with an overview of the most important aspects. Next, it analyzes monetary and fiscal policy interaction in a stylized model of a monetary union, in which monetary and fiscal policy design is modeled as a dynamic stabilization game. Macroeconomic policymaking and adjustment are studied under alternative forms of cooperation and in both symmetric and asymmetric settings.

Keywords: Macroeconomic stabilization, EMU, linear quadratic differential games

JEL codes: C70, E17, E58, E16, E63

Introduction

The introduction of the euro on January 1, 1999 completed the economic policy architecture designed by the Maastricht Treaty on the Economic and Monetary Union (EMU). The single monetary policy has been delegated to the European Central Bank (ECB). The Governing Council of the ECB is charged with the formulation of the single monetary policy and for setting the guidelines for policy implementation; its responsibilities include decisions relating to intermediate monetary objectives, key interest rates and the supply of reserves in the eurosystem. Each member of the Governing Council has one vote and monetary policy decisions require only a simple majority. The Governing Council is composed of the governors of the national Central Banks which fully participate in EMU, and the members of the Executive Board. The Executive Board, in turn, is composed of the President, the Vice-President and four other members and is mainly responsible for the implementation of monetary policy. In this role it provides instructions to the twelve national Central Banks.

Responsibility for national budgetary policy and structural policies, remains with the Member States, subject to their obligations stemming from the Treaty or from secondary legislation such as the Stability and Growth Pact. Wages also continue to be negotiated nationally, according to the prevailing wage bargaining arrangements. The design of an EMU with a highly independent monetary authority and fiscal authorities that are subjected to fiscal restrictions in the form of the Stability and Growth Pact, reflects the opinion that monetary and fiscal policies need to be clearly laid down and constrained to avoid a danger of fiscal profligacy and an ECB that is governed by political and/or national interests of politicians.

With the move to EMU, participating Member States will take an increased mutual interest in their economic performance: a high degree of economic interdependence exists throughout the EMU as a result of the completion of the Single Market. In addition, countries in the euro-area now face the same monetary policy conditions. Economic trends in any part of the currency area can have a bearing on these conditions and can therefore have an impact on other parts of the currency area. Under EMU, consequently, there is a strong case for improved policy co-ordination. Policy co-ordination can contribute to achieving an appropriate economic policy mix for the euro-area as a whole as well as for its constituents. This includes taking into account spill-over effects and possible negative externalities that could occur under non-coordinated decision-making. Also, to avoid free rider behavior where policy-makers renege on their own responsibilities and adopt a wait-and-see approach in an attempt to benefit from the efforts of others.

An elaborate policy coordination system has been designed for the EMU. The annual Broad Economic Policy Guidelines of the Member States and the Community are the central element in this system. They give guidance to the policy-makers at the national and Community levels with regard to macroeconomic and structural conditions. These guidelines seek to ensure consistency in the policy stance across policy instruments and across countries and the full use of available policy tools. General

guidelines apply to the EU and the euro-area as a whole and country-specific guidelines address issues of particular relevance for individual countries.

This paper has two related objectives: Firstly, to provide a basic overview on monetary and fiscal policy design in the EMU. It does not aim at reviewing all aspects of monetary and fiscal policy design in the EMU and the associated literature in depth (see e.g. European Commission (1997) for a very broad survey). Rather, it wants to provide the reader with a good insight on how all issues fit together and what is making EMU such an intriguing institutional framework. The second aim is to provide the reader with a non-technical overview of a research project that analyzed the interaction of monetary and fiscal policies in the EMU using a dynamic game approach.¹ In this approach, the monetary and fiscal authorities interact strategically and implement optimal policies subject to the adjustment dynamics of the EMU economy. A dynamic framework was chosen as macroeconomic adjustment and macroeconomic stabilization are inherently of a dynamic nature. A static framework would not allow to address issues of timing and dynamics in an appropriate way. This approach, in our opinion, provides an insightful way of analyzing –admittedly, in a stylized way– many aspects of monetary and fiscal policy design in the EMU. The analysis is structured as follows: Section 2 reviews the most important aspects of monetary and fiscal policy design in the EMU. Section 3 to 5 present a dynamic stabilization game between the monetary and fiscal policy makers in the EMU.

2. Monetary and fiscal policy design in the EMU: An overview of the main issues

This section summarizes three -interdependent- issues that have played a crucial role in the discussions on EMU.

2.1 Design of monetary and fiscal policies

In the EMU, monetary policy has been delegated to a supra-national authority, the ECB, with a complex framework of objectives, policy instruments and decision-making procedures. According to the Maastricht Treaty, the ECB should safeguard price stability in the EMU and -subject to the condition that it does not interfere with price stability- promote economic growth in the EMU. Its policies are therefore directed at controlling economic developments of the EMU economy: price stability is now to be maintained in the euro-area as a whole, which does not necessarily imply it at any time in each and every country composing the area.

As noted in the introduction, fiscal and structural policies remain delegated to the national level in the EMU as stipulated by the subsidiarity principle of the EU Treaty.² The design of fiscal policies in the EMU is complicated by the set of constraints on national fiscal policy imposed by the Stability and Growth Pact, according to which excessive deficits are to be avoided and subject to sanctions. The Stability and Growth Pact stipulates that Member States adhere to the medium-term objective of budgetary positions “close to balance or in surplus”. This should allow them to keep the general government deficit below 3 per cent of GDP in the face of “normal” cyclical fluctuations

without resorting to pro-cyclical fiscal tightening. Subject to certain provisions, including a waiver in the event of exceptionally severe recessions, pecuniary sanctions can be applied if the deficit threshold is crossed. Multilateral surveillance is exercised through the annual submission to the Commission of programs containing macroeconomic and fiscal projections showing how the countries plan to achieve their medium-term objectives.

The Stability and Growth Pact seeks to address longer-term externalities related to persistent biases toward excessive deficits and to foster monetary policy credibility. The Stability and Growth Pact does, however, not address the issue of whether macroeconomic spillovers in EMU are important enough to necessitate additional coordination of policies. In part it will depend on the nature of the shock encountered. Large symmetric shocks are likely to require strong coordination of policies - including monetary policy- in the EMU. If the shock is country-specific, temporary and does not impinge much on the euro-area aggregate, the appropriate instrument is national fiscal policy, and there may be less need for coordination. If the shock has implications for euro-area wide inflation, the primary instrument should be monetary policy. Monetary policy should also take into account the implications of the fiscal policy stance for prospective price developments, especially if spillovers between monetary and fiscal policies are significant. This is more likely to be the case if large euro-area economies, or a number of small economies simultaneously adjust fiscal policy, since their actions may have an impact on euro-area wide activity and inflation prospects to prompt a monetary policy response.

2.2 Asymmetries in policy preferences, sizes and structures

One of the most important discussions³ in the EMU concerns the consequences of a common monetary policy in a setting with possibly asymmetries in policy preferences and structural characteristics and if EMU is hit by symmetric and asymmetric shocks in divergent macroeconomic conditions. Asymmetries in structural characteristics will lead to differences in the transmission of monetary and fiscal policies between the different EMU countries. The transmission mechanisms of monetary policy for the area as a whole and the individual constituents are, moreover, quite uncertain. There are several potential sources of different regional responses to a common monetary policy. These include differences in: the composition of output; the degree of openness; the level of development and structure of the financial market; sector balance sheet positions; and the flexibility and institutional features of labor and product markets. This aspect is likely to complicate macroeconomic policy design and coordination in the EMU to a significant extent.

Another concern is the possibility that regional conditions could have an unwarranted influence on policy. Even in the United States, despite the high degree of centralization of decision making, there is some evidence that local conditions have an influence on the votes of regional presidents. The eurosystem is even more vulnerable in this regard. The composition of the Governing Council may carry the risk that heterogeneity of preferences about the output-inflation trade-off could

result in undue weight being placed on regional conditions. This, in turn, could make for inefficient choices in ECB policies. The pressures may intensify if the transmission mechanisms differ significantly across the euro-area.

2.3 Macroeconomic policy coordination

In the EMU, the dimension of policy coordination can be decomposed into two elements.⁴ Firstly, the possibility of fiscal policy coordination arises. As noted earlier, EMU leaves fiscal policy design principally to the individual countries but setting a framework of fiscal constraints. It does not foresee the move to a fiscal federation. In an integrated area like the EMU, individual fiscal policies have important effects on the other countries through a variety of spillovers and externalities in goods, labor and financial markets in the EMU area. This makes the possibility of fiscal coordination such an important aspect of macroeconomic policy design in the EMU.

Coordination of fiscal policy has been strengthened considerably since the early 1990s, as the Maastricht Treaty set deficit and debt criteria to be respected before a country could join the euro-area, and the Stability and Growth Pact made these more stringent. The institutional side of coordination has also been enhanced with the Broad Economic Policy Guidelines, the Stability and Growth Pact and the high-level EU policy groups such as Ecofin (Economics and Finance Ministers), the Economic and Financial Committee and the euro-12 Group (a subgroup of the Ecofin specific to EMU).⁵ The instrument of multilateral surveillance is used to reinforce the excessive deficit procedure and coordination of fiscal policies in the EMU area. The ECB plays also a role in this procedure: it expresses its opinions about the stability programs and the broad economic policy guidelines and in the discussions about the achievement of objectives and possible corrective measures that need to be taken.

Secondly, the possibility exists of monetary and fiscal policy coordination at the aggregate EMU level to stabilize output and inflation fluctuations in the EMU economy and to limit regional divergences. This issue has received less attention than the fiscal policy coordination issue.⁶ Nevertheless, the coordination of national fiscal policies with the common monetary policy of the ECB could be an important aspect of EMU, given the existence of interdependencies due to sizeable spillovers and externalities. Italianer (1999) and Bini Smaghi and Casini (2000) review in detail the institutional framework in which policy co-ordination between the ECB and the ECOFIN is situated. The EU Treaty and subsequent European Council meetings emphasized the importance of the macroeconomic dialogue to co-ordinate fiscal policy, monetary policy and wage developments in the EMU. The communication between the ECB and ECOFIN is formally arranged in the form of the presence of the President of ECOFIN in the meeting of the Governing Council of the ECB, having the right to submit motions for deliberation (but having no voting right). On its turn, the president of the ECB participates in the ECOFIN Council meetings. Theoretical analyses by Levine and Brociner

(1994), Hughes Hallett and Ma (1999) have suggested that this form of policy coordination is indeed relevant in the EMU context.

3. Monetary and fiscal policy design in the EMU: An analytical framework

The previous section identified the issues of macroeconomic policy design, asymmetries, and policy cooperation as distinguishing elements of the EMU. These also have a crucial role in our theoretical analysis of macroeconomic policy design in the EMU. Monetary and fiscal policy design in our analysis are the outcome of a dynamic stabilization game in which the ECB and the national fiscal authorities are engaged.

In this game, the ECB is concerned with inflation and real activity in the aggregate EMU economy.⁷ Moreover, we consider interest rate smoothing as an additional objective. The national fiscal authorities only care about inflation and output in their own country. The Stability and Growth Pact is modeled as an objective of deficit stabilization (or deficit smoothing). Symmetric and asymmetric settings and the effects on the transmissions of monetary and fiscal policies in the EMU, have a prominent role in the analysis. The impact of these asymmetries under alternative policy regimes, has also been given attention since the consequences of asymmetries will partly depend on the policy regime in place. Finally, the project has studied in detail alternative regimes of macroeconomic policy cooperation and their effects in a dynamic model of macroeconomic policy making and adjustment in the EMU. Fiscal policy coordination in the EMU has been given much attention.⁸

The stylised EMU model developed in Engwerda et al. (2002), Engwerda et al. (2001), van Aarle et al. (2001 b,c) is based on the original model of Turnovsky et al. (1988) and Neck and Dockner (1995) on monetary policy making in a two-country setting. It extends the model to a two-country monetary union and adds also fiscal stabilization policy. The framework ignores the external interaction of the EMU countries with the non-EMU countries and also the dynamic implications of government debt and net foreign asset accumulation. It consists of the following equations:

$$y_1(t) = \mathbf{d}_1 s(t) - \mathbf{g}_1 r_1(t) + \mathbf{r}_1 y_2(t) + \mathbf{h}_1 f_1(t) \quad (1a)$$

$$y_2(t) = -\mathbf{d}_2 s(t) - \mathbf{g}_2 r_2(t) + \mathbf{r}_2 y_1(t) + \mathbf{h}_2 f_2(t) \quad (1b)$$

$$s(t) = p_2(t) - p_1(t) \quad (2)$$

$$r_1(t) = i_E(t) - \dot{p}_1(t) \quad (3a)$$

$$r_2(t) = i_E(t) - \dot{p}_2(t) \quad (3b)$$

$$m_1(t) - p_1(t) = \mathbf{k}_1 y_1(t) - \mathbf{l}_1 i_E(t) \quad (4a)$$

$$m_2(t) - p_2(t) = \mathbf{k}_2 y_2(t) - \mathbf{l}_2 i_E(t) \quad (4b)$$

$$\dot{p}_1(t) = \mathbf{x}_1 y_1 \quad (5a)$$

$$\dot{p}_2(t) = \mathbf{x}_2 y_2 \quad (5b)$$

in which y denotes real output, s competitiveness of country 2 vis-à-vis country 1, r the real interest rate, p the price level, f the real fiscal deficit, i_E the nominal interest rate and m nominal money balances. All variables are in logarithms, except for the interest rate which is in perunages, and denote deviations from their long-run equilibrium (balanced growth path) that has been normalized to zero, for simplicity. A dot above a variable denotes its time derivative.

Equation (1) gives output in the EMU countries as a function of competitiveness in intra-EMU trade, the real interest rate, the foreign output and the domestic fiscal deficit. Competitiveness is defined in (2) as the output price differential. Real interest rates are defined in (3) as the difference between the EMU wide nominal interest rate, i_E , and domestic inflation. Note that (3) implies that, temporarily, real interest rates diverge among countries if inflation rates are different. (4) provides the demand for the common currency. (5) relates output to inflation by a Phillips-curve type relation.

We assume that the fiscal authorities control their fiscal policy instrument such as to minimize the following quadratic loss function which features domestic inflation, output and the fiscal deficit:

$$\min_{f_1} J_1(t_0) = \frac{1}{2} \int_0^{\infty} \{a_1 \dot{p}_1^2(t) + b_1 y_1^2(t) + c_1 f_1^2(t)\} e^{-q(t-t_0)} dt \quad (6a)$$

$$\min_{f_2} J_2(t_0) = \frac{1}{2} \int_0^{\infty} \{a_2 \dot{p}_2^2(t) + b_2 y_2^2(t) + c_2 f_2^2(t)\} e^{-q(t-t_0)} dt \quad (6b)$$

in which q denotes the rate of time preference and a, b and c represent preference weights that are attached to the stabilization of inflation, output and fiscal deficits, respectively. Deficits in the loss function may reflect the possibility that excessive deficits in the EMU will be subject to sanctions, as proposed in the “Excessive Deficit Procedure” of the Treaty of Maastricht on the European Union (art. 104c) and its more recent extension into the Stability and Growth Pact. Therefore, countries will prefer low fiscal deficits to high deficits. Another way to formulate this is that the Stability and Growth Pact introduces deficit stabilization, or deficit smoothing, as an explicit objective of fiscal policy design.

As stipulated in the Maastricht Treaty, the ECB directs the common monetary policy at stabilizing inflation and, as long as not in contradiction to inflation stabilization, stabilizing output in the aggregate EMU economy.⁹ It is assumed that the ECB operates an interest rate targeting strategy.¹⁰ Moreover, we will assume that the active use of monetary policy implies costs for the monetary policymaker: other things equal it would like to keep its policy instrument constant, avoiding large swings. Such an interest rate smoothing objective in the preferences of the monetary authority is currently receiving more attention in monetary policy analysis (see e.g. Sack (2000)). Consequently, we assume that the ECB is confronted with the following optimization problem:

$$\min_{i_E} J_E(t_0) = \frac{1}{2} \int_0^{\infty} \{a_E \dot{p}_E^2(t) + b_E y_E^2(t) + c_E i_E^2(t)\} e^{-q(t-t_0)} dt \quad (7)$$

where $p_E(t) := \mathbf{w}p_1(t) + (1-\mathbf{w})p_2(t)$ and $y_E(t) := \mathbf{w}y_1(t) + (1-\mathbf{w})y_2(t)$, in which \mathbf{w} and $1-\mathbf{w}$ denote the relative sizes of the economies of country 1 and country 2 in the aggregate EMU economy. The model (1-5) can be reduced to two output equations:

$$y_1(t) = b_1 s(t) - c_1 i_E(t) + a_1 f_1(t) + \frac{\mathbf{r}_1}{k_1} a_2 f_2(t) \quad (8a)$$

$$y_2(t) = -b_2 s(t) - c_2 i_E(t) + \frac{\mathbf{r}_2}{k_2} a_1 f_1(t) + a_2 f_2(t) \quad (8b)$$

with $a_1 := \frac{\mathbf{h}_1 k_2}{k_1 k_2 - \mathbf{r}_1 \mathbf{r}_2}$, $a_2 := \frac{\mathbf{h}_2 k_1}{k_1 k_2 - \mathbf{r}_1 \mathbf{r}_2}$, $b_1 := \frac{\mathbf{d}_1 k_2 - \mathbf{r}_1 \mathbf{d}_2}{k_1 k_2 - \mathbf{r}_1 \mathbf{r}_2}$, $b_2 := \frac{\mathbf{d}_2 k_1 - \mathbf{r}_2 \mathbf{d}_1}{k_1 k_2 - \mathbf{r}_1 \mathbf{r}_2}$, $c_1 := \frac{\mathbf{g}_1 k_2 + \mathbf{r}_1 \mathbf{g}_2}{k_1 k_2 - \mathbf{r}_1 \mathbf{r}_2}$, $c_2 := \frac{\mathbf{g}_2 k_1 + \mathbf{r}_2 \mathbf{g}_1}{k_1 k_2 - \mathbf{r}_1 \mathbf{r}_2}$, $k_1 := 1 - \mathbf{g}_1 \mathbf{x}_1$ and $k_2 := 1 - \mathbf{g}_2 \mathbf{x}_2$. The dynamics of the model

can then be written as a linear differential equation with competitiveness, $s(t)$, as the scalar state variable, the national fiscal deficits, $f_i(t)$, $i = \{1, 2\}$, and the common interest rate, $i_E(t)$, as control variables:

$$\dot{s}(t) = -\mathbf{f}_1 f_1(t) + \mathbf{f}_2 f_2(t) + \mathbf{f}_3 i_E(t) + \mathbf{f}_4 s(t) \quad s(0) =: s_0 \quad (9)$$

in which $\mathbf{f}_1 := (\mathbf{x}_1 - \mathbf{x}_2 \frac{\mathbf{r}_2}{k_2})a_1$, $\mathbf{f}_2 := (\mathbf{x}_2 - \mathbf{x}_1 \frac{\mathbf{r}_1}{k_1})a_2$, $\mathbf{f}_3 := \mathbf{x}_1 c_1 - \mathbf{x}_2 c_2$ and $\mathbf{f}_4 := -(\mathbf{x}_1 b_1 + \mathbf{x}_2 b_2)$. The

initial value of the state variable, s_0 , measures any initial disequilibrium in intra-EMU competitiveness. Such an initial disequilibrium in competitiveness could be the result of, e.g., differences in fiscal policies in the past or some initial asymmetric shock in the EMU.

4. Macroeconomic policy design and coordination in the EMU: Alternative policy regimes

This project has focused on analyzing outcomes under alternative modes of policy cooperation in the EMU. We have analyzed macroeconomic policy design and macroeconomic adjustment in three alternative macroeconomic policy regimes: (i) non-cooperative monetary and fiscal policies, (ii) full cooperation and (iii) partial cooperation.

(i) The non-cooperative case (N): in the non-cooperative case players minimize their cost functions (13a-c) with respect to the dynamic law of motion (7) of the system, assuming Nash open-loop strategies. (ii) The cooperative case (C): in the full cooperation case players minimize a common cost function: $J_C = \mathbf{t}_1^C J_1 + \mathbf{t}_2^C J_2 + \mathbf{t}_E^C J_E$ subject to (7); \mathbf{t}^C equals the bargaining power of the players with $\mathbf{t}_1^C + \mathbf{t}_2^C + \mathbf{t}_E^C = 1$. (iii) Cases with coalitions of policymakers ((1,2), (1,E), (2,E)): with a set of more than two macroeconomic policymakers possibilities exist for the formation of coalitions of policymakers that cooperate between themselves and interact non-cooperatively with non-members of the coalition. Particularly in a monetary union consisting of different countries with one common

monetary authority, it seems an interesting case to explore such coalition formation in more detail. (a) Coalition (1,2) with cost functions: $J_{(1,2)} = \mathbf{t}_1^{(1,2)} J_1 + \mathbf{t}_2^{(1,2)} J_2$ and J_E where $\mathbf{t}_1^{(1,2)} + \mathbf{t}_2^{(1,2)} = 1$. This case of fiscal cooperation has received much attention in the context of EMU. Fiscal cooperation can take many practical forms in the EMU context: from cooperation on an ad hoc basis up to the formation of a fully fledged federal fiscal authority. Since the E(M)U is currently far from fiscal federation, the first interpretation here of fiscal cooperation is more realistic and preferred here. (b) Coalition (1,E) with cost functions: $J_{(1,E)} = \mathbf{t}_1^{(1,E)} J_1 + \mathbf{t}_E^{(1,E)} J_E$ and J_2 where $\mathbf{t}_1^{(1,E)} + \mathbf{t}_E^{(1,E)} = 1$. In this case, country 1 and the ECB form a coalition which interacts non-cooperatively with country 2. (c) Coalition (2,E) with cost functions $J_{(2,E)} = \mathbf{t}_2^{(2,E)} J_2 + \mathbf{t}_E^{(2,E)} J_E$ and J_1 where $\mathbf{t}_2^{(2,E)} + \mathbf{t}_E^{(2,E)} = 1$. Here, country 2 and the ECB coordinate their policies and act in a non-cooperative fashion against country 1.

In all cases, as shown in detail in van Aarle et al. (2001), the optimal strategies that result in this open-loop linear-quadratic (LQ) differential game are a linear function of the current level of the state variable:

$$\begin{pmatrix} f_1(t) \\ f_2(t) \\ i_E(t) \end{pmatrix} = H_i s(t) \quad i = \{N, C, (1,2), (1,E), (2,E)\} \quad (10)$$

in which H is a 3 by 1 vector with feedback coefficients. Furthermore, the resulting closed-form solution is described by the differential equation $\dot{s}(t) = -a_{cl,i} s(t)$ with $s(0) := s_0$, where $a_{cl,i}$ is the adjustment speed of the closed-loop system in case of equilibrium i .

We have noted before that symmetries and asymmetries between countries in terms of policy preferences, structural parameters (which reflect the underlying institutions in the goods, labor and financial markets) and size are a determining feature of the EMU. In order to have a good understanding of the effects of asymmetries between participating countries, it is essential to understand the workings of macroeconomic policies in a symmetric EMU. Therefore, the project has investigated intensively the symmetric case to use it as a reference point in the analysis of various asymmetries and their consequences. In the symmetric case all structural and preference parameters are equal in country 1 and country 2 and both countries are of equal size and have equal bargaining weight in a coalition.

In Engwerda et al. (2000) and van Aarle et al. (2001 b), we derived a number of analytical properties of the non-cooperative, the cooperative and the fiscal coalition equilibria of the symmetric case. Firstly, w.r.t. the number of equilibria that may appear in the game, one finds that in the cooperative and the fiscal coalition case the game has always a unique equilibrium. If $k > \mathbf{r}$ (a condition saying that openness should not be too large and which is likely to hold in most cases) the non-cooperative game also has a unique equilibrium. If $k \leq \mathbf{r}$ the number of equilibria may vary

between zero and two. In the remainder of the paper, we will restrict in the rest of this section to the case that the non-cooperative game has a uniquely defined equilibrium.

Secondly, in the symmetric case we observe in the non-cooperative, the cooperative and the fiscal coalition case that $f_1(t) = -f_2(t)$ and that the ECB does not influence the game, neither in a direct way (i.e. $i_E(t) = 0$) nor in an indirect way (i.e. via its parameters) in the symmetric case. These statements do not hold for the case of a coalition between the ECB and one fiscal player. There, the fiscal instruments differ and the ECB uses its instruments actively to reach its goals. The symmetry assumptions are crucial too, if they are dropped the ECB gets also actively involved into the game also in the non-cooperative, the cooperative and the fiscal coalition case.

Some further general conclusions for the symmetric case can be derived. It can be shown: that the convergence speed of the cooperative case and the fiscal cooperation case are equal and higher than the non-cooperative case and that the adjustment speed is a monotonically increasing function of the fiscal stringency parameter c . With respect to the performance criteria we showed that the costs for the fiscal players are the same in the cooperative case and the fiscal coalition case and that these costs are lower than in the non-cooperative case. The ECB is indifferent between the three different cases in this symmetry EMU. In other words, it has little to gain from coordination of its monetary policy with the national fiscal policies in (close to) symmetric settings.

5. A Simulation Analysis

In this section we consider the differential game on macroeconomic stabilization in the EMU that was set up in Sections 3 and 4, using scenarios of a stylized example. We analyze three different simulations. A symmetric base scenario is analyzed first. Next, a situation with asymmetric transmission of fiscal policy in both countries is analyzed. Finally, we assume that the countries differ w.r.t. the short-run output-inflation trade-off. Outcomes are analyzed for all the five different equilibria outlined in Section 3: the non-cooperative equilibrium, the fully cooperative equilibrium, and the partial cooperative equilibria (the fiscal coalition and the coalitions between the ECB and a fiscal player).

In order to obtain some insight into the question which coalition might be realized and which are less plausible, we introduce some terminology. Each of the five policy regimes outlined in the above subsections is called a coalition form and each group of two or more players that cooperate in a coalition form a coalition. We say that a certain coalition form is supported by player i , if player i has no incentive to deviate from this coalition form. We say that this coalition form is internally supported if all players in the coalition support the coalition form.¹¹ If a coalition form is internally supported, then we will call this coalition form sustainable, that is, in such a coalition form no player has an incentive to deviate and leave this coalition form. Finally, we call a coalition form unsustainable if one or more players has/have an incentive to deviate from this coalition form. In that case, players inside

and outside the coalition can improve by joining another coalition form. Note that a coalition form which is not internally supported is in principle not viable. Reasons why such a coalition form could still take place are the possibility that side-payments take place or that some other institutional arrangement is in place that could secure the existence of otherwise not sustainable coalitions. Side-payments and institutional arrangements could therefore allow for a broad range of coalitions to be supported.

5.1 A reference point: policy design in a symmetric EMU

In this first example, starting point is a situation where countries are symmetric. In the symmetric baseline case, the countries are equally weighted in the ECB's loss function and the following values for the structural model parameters are used¹²: $\mathbf{g} = 0.4$, $\mathbf{d} = 0.2$, $\mathbf{r} = 0.4$, $\mathbf{h} = 1$ and $\mathbf{x} = 0.25$.¹³ The initial state of the monetary union economy is $s_0 = 0.05$ (implying an initial disequilibrium of 5% in competitiveness between the two countries). Concerning the preference weights in the objective functions of the fiscal players, the following values have been assumed: $\mathbf{a} = 2$, $\mathbf{b} = 5$, $\mathbf{c} = 2.5$ and $\mathbf{q} = 0.15$. It is assumed that the ECB cares relatively more about inflation than output: $\mathbf{a}_E = 2.5$, $\mathbf{b}_E = 1$, $\mathbf{c}_E = 2.5$. The countries are equally sized, $\mathbf{w} = 0.5$, and the following symmetric bargaining powers in the coalitions are set: $\mathbf{t}^C = \{1/3, 1/3, 1/3\}$, $\mathbf{t}^{(1,2)} = \{1/2, 1/2\}$, $\mathbf{t}^{(1,E)} = \{1/2, 1/2\}$, and $\mathbf{t}^{(2,E)} = \{1/2, 1/2\}$.

Figure 1 displays the adjustment in this symmetric base case,

[Insert Figure 1 here]

In the symmetric case, the cooperative and the fiscal coalition equilibria coincide, as noted at the end of Section 4. The initial disequilibrium in intra-EMU competitiveness implies that output is initially above the long-run equilibrium in country 1 and below the long-run equilibrium in country 2. This initial condition together with the monetary and fiscal policy reactions, leads to the observed adjustment patterns. The adjustment of intra-EMU competitiveness is given in panel (a). The adjustments of the policy variables are found in panels (b)-(d). In the non-cooperative case, the cooperative case and the fiscal coalition case we find the behavior noted already in Section 4 that the ECB has no active policy and that the fiscal policy reactions in both countries are exactly opposite. The common interest rate, panel (b), only reacts in the case of a coalition with one fiscal policy maker: in that case the common interest rate is partly targeted at the situation in the country with which the ECB has formed a coalition. This leads to a higher interest rate in case a coalition is formed with country 1 and a lower interest rate when a coalition is formed with country 2. This helps adjustment in the country with which the ECB forms a coalition but increases the adjustment burden for the other country. Panels (e) and (f) display output in country 1 and 2 in the different cases. In the cooperative

case and the fiscal coalition case, fiscal policy activism is lower than in the non-cooperative case, because higher fiscal policy activism in one country has negative spillovers on the adjustment burden of the other country. In these cases such policy externalities from individual fiscal policies are internalized when designing optimal fiscal stabilization strategies for the entire EMU.

In Table 1 the resulting losses in the five different cases of this symmetric baseline case are given.

[Insert Table 1 here]

In this symmetric case, the properties noted in Section 4 concerning the adjustment speed can be directly verified: the adjustment speed (measured by the size of the a_d 's) is fastest under fiscal cooperation and the Pareto case. Also, it is seen that the coalitions of one fiscal policymaker and the ECB have the slowest adjustment speed, a feature that will reappear in other simulations as well, although we did not establish it as a general result in Section 4, because the expressions in these cases of one fiscal player and the ECB forming a coalition are complicated. In that sense, these coalitions tend to inefficiencies and in particular to place a large adjustment burden on the fiscal player that is held outside the coalition. Moreover, the fiscal coalition is internally supported. From the analysis in the previous section, we know that the losses in the Pareto case and the fiscal coalition form coincide. Both are sustainable in this case, whereas the coalitions (1, E) and (2, E) are unsustainable as both the ECB and the fiscal players would rather leave the arrangement and even prefer to play entirely non-cooperative than to remain in such a coalition.

5.2 Asymmetric fiscal policy transmissions in the EMU

In the second simulation, we analyze a situation where the fiscal policy is transmitted differently in both countries. It is assumed that the elasticity of output w.r.t. fiscal policy is lower in country 2 than in country 1: $h_1 = 1$ and $h_2 = 0.6$. All other parameters are the same as in the baseline case. Figure 2 displays the adjustment in this case

[Insert Figure 2 here]

In this asymmetric setting, the adjustment and policy strategies are no longer perfectly (anti-) symmetric in both countries and the Pareto and fiscal coalition case no longer coincide. In particular, the reduced effectiveness of its instrument implies an increased adjustment burden for country 2, as witness significantly larger output losses, higher deficits and slower adjustment compared to the base case. On the other hand, the slower adjustment of country 2 implies faster adjustment for country 1 in the Nash case. In the cooperative case and fiscal coalition case it shares in the increased adjustment

burden of country 2 by running smaller fiscal surpluses which retard the adjustment of its own high output but thereby helps in stabilizing the economy of country 2. The ECB now reacts in all strategic settings as its objective functions imply that its optimal strategy instrument is sensitive to asymmetries in the EMU area. Interest rates are reduced -with the only exception of the case where it forms a coalition with country 1- to support the adjustment in country 2. Table 1 gives the resulting welfare losses and the adjustment speeds in the different cases.

The fiscal authority of country 1 and the ECB have a fiscal coalition as their most preferred outcome. The fully cooperative case is unsustainable since country 1 and the ECB would still prefer a coalition between themselves or even the non-cooperative case. Country 2 prefers a coalition with the ECB; however, that is not likely to be sustainable. Country 2 would, on the other hand, still prefer the fiscal coalition to the non-cooperative equilibrium. The highest adjustment speed is also obtained in this fiscal coalition case.

5.3. An asymmetry in the degree of nominal rigidities

In this example, we analyze the consequences of differences in the extent of nominal rigidities in both countries. The existence of nominal rigidities is reflected in the parameter \mathbf{x} . Amongst others things, nominal rigidities affect the transmission of fiscal policy and monetary policy and \mathbf{x} is therefore one of the crucial parameters of the model. In this example we assume that country 2 is now characterized by more nominal rigidities than country 1, $\mathbf{x}_1 = 0.25$ and $\mathbf{x}_2 = 0.15$. All other parameters are the same as in the baseline case. The adjustment under this scenario provides Figure 3.

[Insert Figure 3 here]

Optimal policies and adjustment are much different from the baseline case. With its economy displaying larger nominal rigidities, country 2 faces higher adjustment burdens and it chooses a stronger stabilization policy compared to the baseline case and this for all different equilibria. The slower adjustment in country 2 benefits to some extent the adjustment of country 1: its adjustment need is somewhat reduced. A peculiar case in the coalition of country 1 and the ECB, where a high interest rate and a high fiscal surplus in country 1 reduce output in country 1 below the long-run equilibrium, despite the initial competitive advantage. Country 2 suffers significantly from this combination of a high interest rate policy set by the ECB and low output in country 1, as also the losses in Table 1 clearly indicate. Note also the very low adjustment speed under this coalition. Country 2 prefers the cooperative case because there the higher need for adjustment in country 2 and in this case this need can be internalized into the monetary policy strategy of the ECB and the fiscal strategy of country 2. For country 1 and the ECB the most preferred equilibria are the fiscal coalition and the non-cooperative case, respectively.

Conclusion

The establishment of the EMU has raised much interest to issues of monetary and fiscal policy design in such an arrangement. Prominent are issues of symmetry of the participating countries and the role of policy coordination since individual policies are likely to have significant spillovers in a highly integrated economic area such as the euro-area. It is to be expected that EMU by introducing a common monetary policy and restrictions on national fiscal policies is likely to increase the need for macroeconomic policy cooperation. However, it is far from obvious that more policy cooperation will automatically be forthcoming, or if it does, in the most preferred form. In particular, asymmetries in policy preferences and structural conditions are likely to prevail in the EMU, thereby complicating the process of macroeconomic policy cooperation to a considerable extent.

This paper has surveyed the most important aspects of monetary and fiscal policy design in the EMU. In addition, the interaction between the ECB and national fiscal authorities was modeled as a dynamic game of macroeconomic stabilization in the EMU. Using numerical examples, we illustrated the complex effects that are produced by the various forms of policy cooperation. Moreover the sustainability of a certain type of coalition and its implications for the optimal strategies and the resulting macroeconomic adjustment, was seen to be influenced by initial settings of preferences and the structural model parameters. We found that the cooperation is often efficient for the fiscal players and, moreover, that the fiscal players' cooperation (against the ECB) leads to a Pareto improvement for them. On the other hand, in many simulations full cooperation does not induce a Pareto improvement for the ECB, while the governments' coalitions imply a considerable loss for the ECB compared to the non-cooperative and fully cooperative cases. Asymmetries can drastically influence the outcomes under EMU, as the simulation exercises demonstrated. Future research on the sensitivity of outcomes to the values of the various model parameters could be useful. Moreover the effects of adding more countries or using alternative solution concepts of the dynamic stabilization game should be investigated.

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References

- van Aarle, B., J. Engwerda, J. Plasmans and A. Weeren (2001 a) "Macroeconomic Policy Interaction under EMU: A Dynamic Game Approach," Open Economies Review 12, 29-60.
- van Aarle, B., J. Engwerda and J. Plasmans (2001 b) "Monetary and Fiscal Policy Interaction in the EMU: A Dynamic Game Approach," CESifo Working Paper No. 437
- van Aarle, B., G. Di Bartolomeo, J. Engwerda and J. Plasmans (2001 c), "Coalitional Behavior in an Open-Loop LQ-Differential Game of the EMU," IFAC Proceedings 2001.
- Beetsma, R. and L. Bovenberg (1998) "Monetary Union without Fiscal Coordination May Discipline Policymakers," Journal of International Economics 45, 239-258.
- Beetsma, R. and H. Uhlig (1999) "An Analysis of the Stability and Growth Pact," Economic Journal 109, 546-571.
- Bini Smaghi, L. and C. Casini (2000) "Monetary and Fiscal Policy Co-operation: Institutions and Procedures in EMU," Journal of Common Market Studies 38, 375-391.
- Buti, M., D. Franco and H. Ongena (1998) "Fiscal Discipline and Flexibility in EMU: The Implementation of the Stability and Growth Pact," Oxford Review of Economic Policy 14, 81-97.
- De Grauwe, P. (2000) "Monetary Policies in the Presence of Asymmetries," CEPR Discussion Paper, No. 2393.
- Dixit, A. (2000), "A Repeated Game Model of Monetary Union", Economic Journal 110, 759-780.
- Engwerda, J.C., B. van Aarle and J.E.J. Plasmans (1999) "The (In)finite Horizon Open-loop Nash LQ game: An Application to the EMU," Annals of Operations Research 88, 251-273.
- Engwerda, J.C., B. van Aarle and J.E.J. Plasmans (2002) "Cooperative and Non-cooperative Fiscal Stabilisation Policies in the EMU," Journal of Economic Dynamics and Control 26, 451-481.
- European Commission (1997) "Economic Policy in EMU", Economic Papers. No. 124 and 125. European Commission. Brussels, 236 p.
- Godbillon, B. and M. Sidiropoulos (2001) "Designing Fiscal Institutions in a Monetary Union," Open Economies Review 12, 163-179.

Gros, D. and C. Hefeker (2000) "One Size Must Fit All National Divergences in a Monetary Union," CESifo Working Paper, No. 326.

von Hagen, J. and R. Suppel (1994) "Central Bank Constitutions for Federal Monetary Unions," European Economic Review 38, 774-782.

Hughes Hallett, A. and Y. Ma (1996) "Changing Partners: the Importance of Coordinating Fiscal and Monetary Policies within a Monetary Union," The Manchester School of Economic and Social Studies 64, 115-134.

Hughes-Hallett, A. and L. Piscitelli (1999) "EMU in Reality: The Effect of a Common Monetary Policy on Economies with Different Transmission Mechanisms," Empirica 26, 337-358.

Italianer, A. (1999) "The Euro and Internal Economic Policy Coordination," Empirica 26, 201-216.

Levine, P. and A. Brociner (1994) "Fiscal Coordination under EMU and the Choice of Monetary Instrument," Journal of Economic Dynamics and Control 18, 699-729.

Neck, R. and E. Dockner (1995) "Commitment and Coordination in a Dynamic Game Model of International Economic Policy-Making," Open Economies Review 6, 5-28.

Sack, B. (2000) "Does the Fed Act Gradually? A VAR Analysis," Journal of Monetary Economics 46, 229-256.

Turnovsky, S., T. Basar and V. d'Orey (1988) "Dynamic Strategic Monetary Policies and Coordination in Interdependent Economies," American Economic Review 78, 341-361.

Table 1
Costs and Adjustment Speeds

	Nash (N)	Pareto (C)	(1,2)	(1, E)	(2, E)
5.1 <i>Symmetric EMU</i>					
J_1	0.3596	0.3032	0.3032	0.4145	2.4911
J_2	0.3596	0.3032	0.3032	2.4911	0.4145
J_E	0	0	0	0.0088	0.0088
a_{cl}	0.1007	0.1162	0.1162	0.0933	0.0933
5.2 <i>Asymmetric Fiscal Transmission</i>					
J_1	0.2950	0.3619	0.2925	0.3395	3.4711
J_2	0.6201	0.2951	0.4736	3.5548	0.2541
J_E	0.0060	0.0397	0.0009	0.0125	0.2085
a_{cl}	0.1094	0.1219	0.1278	0.1048	0.0950
5.3 <i>Asymmetric Rigidities</i>					
J_1	0.4169	0.4110	0.3959	1.7418	2.3249
J_2	0.4449	0.3323	0.3512	11.401	0.4226
J_E	0.0019	0.0047	0.0053	0.0406	0.0037
a_{cl}	0.0933	0.1053	0.1053	0.0627	0.0930

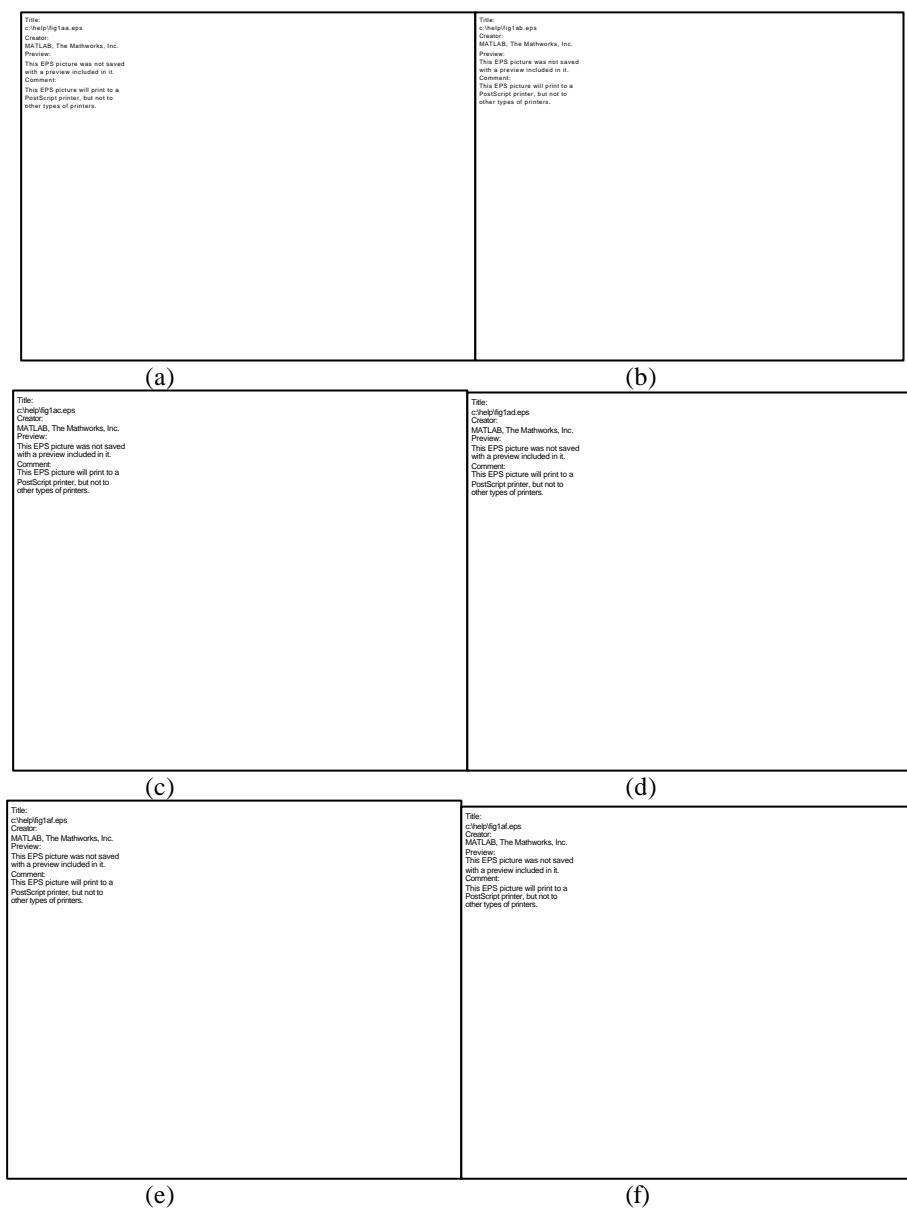


Figure 1
 Symmetric Base Case

— Nash --- Pareto (1,2) -- -- (1,E) - · - (2,E)

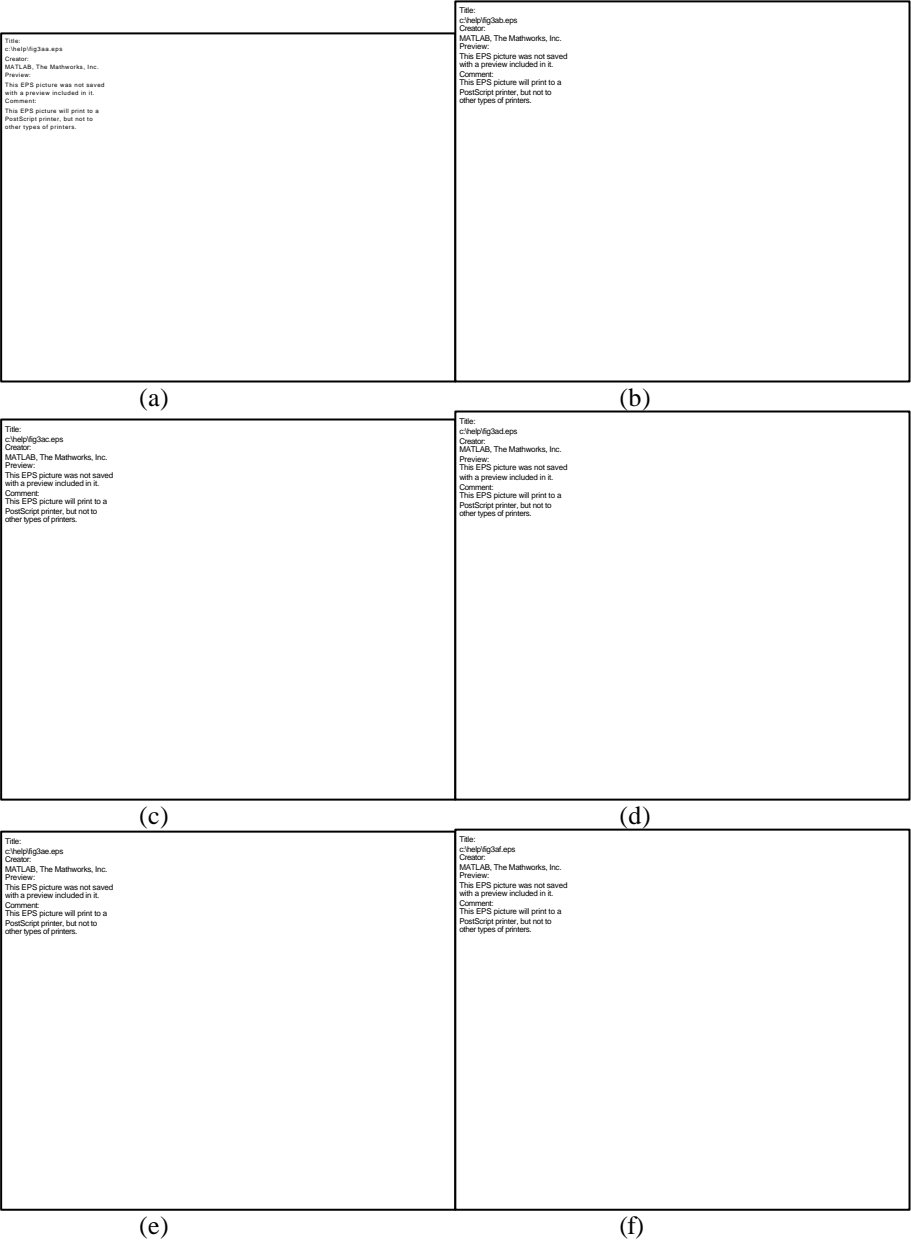


Figure 2
Asymmetric Fiscal Transmission, $\eta_1 = 1, \eta_2 = 0.6$.

— Nash --- Pareto (1,2) - - - (1,E) - · - (2,E)

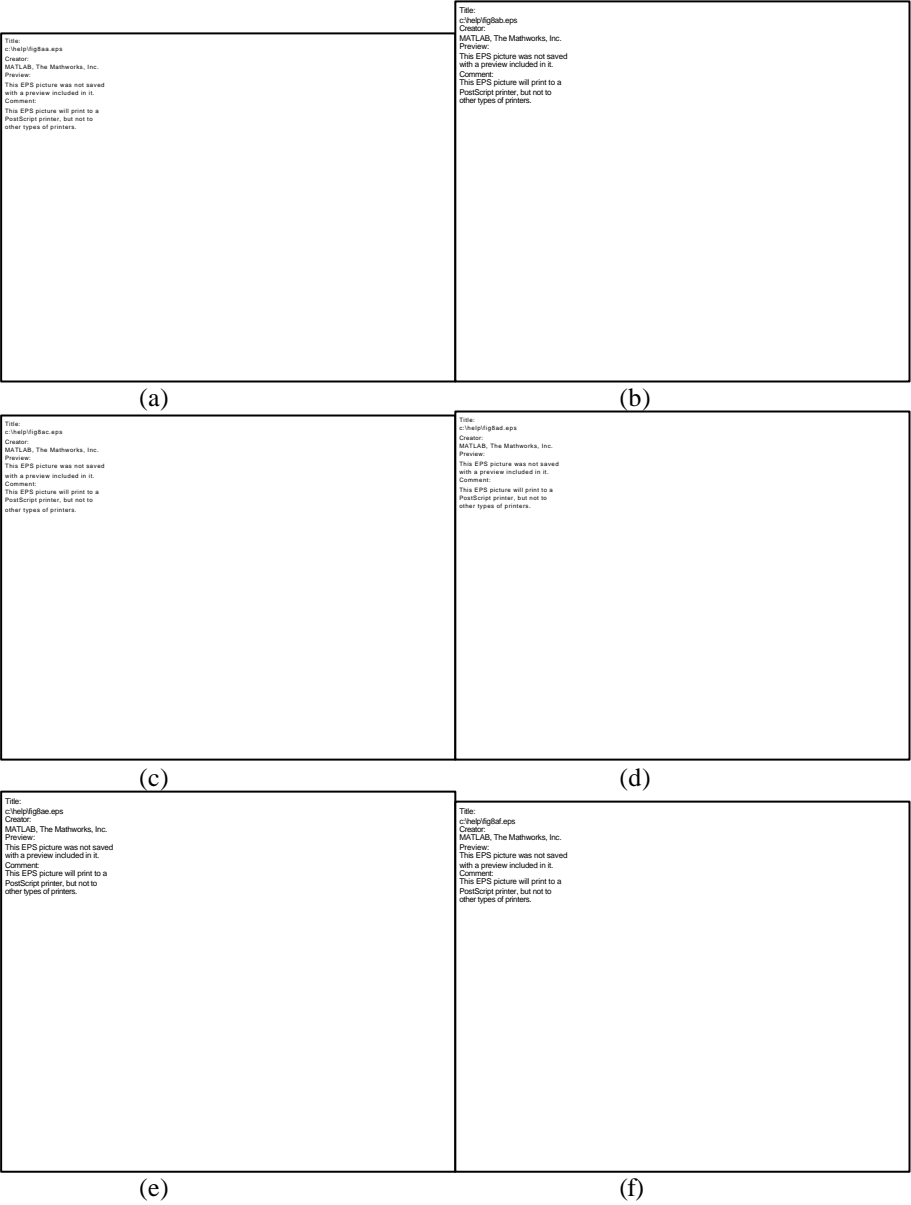


Figure 3
Asymmetric Nominal Rigidities, $\hat{i}_1=0.25$, $\hat{i}_2=0.15$

— Nash --- Pareto (1,2) -- (1,E) - · - (2,E)

Endnotes

¹ The reader interested in all technical details is referred to Engwerda et al. (2002), Engwerda et al. (2001), van Aarle et al. (2001a,b,c).

² An important aspect of fiscal policy in the EMU is the fact that fiscal relations within the EU differ considerably from those in fully-fledged federations: notwithstanding certain tendencies towards more fiscal harmonization and fiscal federalism, fiscal policy design remains predominantly a national competence in the EMU. The Community's budget is very small relative to that of the member States and is not undertaking any stabilization function. It is frequently argued that a federal fiscal structure which allows centralized stabilization is an important concomitant of monetary union, and that Europe may be at a severe disadvantage in its absence.

³ See e.g. de Grauwe (2000), Hughes Hallett and Piscitelli (1999) and Gros and Hefeker (2000) on the asymmetric transmission of a common monetary policy. The issue of EMU-wide vs. individual country variables influencing monetary policymaking of the ECB is analysed e.g. in von Hagen and Sueppel (1994).

⁴ Policy coordination and policy cooperation are used as interchangeable concepts in the paper. In a stylized interpretation, monetary union could be considered as an institutional framework to implement monetary policy cooperation between countries by delegating the design of monetary policy to a supranational monetary authority. In the context of EMU also external coordination of macroeconomic policies with non-EMU countries could be a relevant issue. In theoretical and practical policy analysis this aspect has, however, not received so much interest until so far.

⁵ In several other areas there are also specialized procedures for detailed policy co-ordination. These procedures are e.g. concerned with advancing the process of structural reform in labor, product and capital markets (the s.c. Luxembourg and Cardiff processes). In June 1999, the Cologne European Council initiated the Macroeconomic Dialogue. It brings together both policy-makers and representatives of the social partners for an exchange of views on economic developments and prospects so as to foster a greater understanding of the policy requirements implied by EMU.

⁶ Quite some literature has been devoted to the effects of fiscal coordination and fiscal-monetary coordination on incentive structures in the EMU, using static Barro-Gordon type approaches, see e.g. Beetsma and Bovenberg (1998), Beetsma and Uhlig (1999) and Dixit and Lambertini (2000). Such issues are not addressed in our project, which, moreover concentrates entirely on a dynamic setting of monetary and fiscal stabilization policies in the EMU.

⁷ In van Aarle et al. (2001b) we have also experimented with an objective function of the ECB that is more sensitive to conditions in individual countries. It is shown that this will distort the monetary policy of the ECB towards conditions in individual countries in particular if large asymmetries exist between countries.

⁸ In particular, we focused on the possible effects of the Stability and Growth Pact and asymmetric settings on fiscal coordination in the EMU. In Engwerda et al. (1999) the effects of non-cooperative macroeconomic policies in the EMU have been analyzed. Fiscal cooperation has been analyzed in Engwerda et al. (2002). van Aarle et al. (2001 b,c) analyze macroeconomic adjustment under non-cooperative, partial cooperation and full cooperation.

⁹ The ECB enjoys a very high degree of formal independence, with the Maastricht Treaty requiring that the central bank be free of political control over monetary policy. The Maastricht Treaty makes the ECB accountable to European institutions, but not to national parliaments. The ECB aims at maintaining price stability and -

provided that it does not interfere with the price stability objective- to foster economic growth in the euro-area as a whole. Price stability was defined in 1998 as a year-on-year increase in the Harmonised Index of Consumer Prices for the euro-area of below 2 per cent. In late 1998, the Governing Council of the ECB agreed on a quantitative reference value for monetary growth and the definition of the monetary aggregate. The Governing Council decided to set the reference value of M3 growth at 4.5 per cent per annum.

¹⁰ An important question concerns the (mix of) policy instruments operated by the ECB. In the monetary targeting case, the common money supply, $m_E(t) := \omega m_1(t) + (1-\omega)m_2(t)$, is exogenous and the policy instrument of the ECB. The common interest rate then clears the common money market. In the interest targeting case, the common interest rate is the policy instrument of the ECB and the common money market is cleared by adjustments in the money supply. In Engwerda et al. (1999) and van Aarle et al. (2001 a) the ECB implements a monetary targeting strategy, whereas in van Aarle et al. (2001 b,c) the ECB adopts an interest rate targeting strategy.

¹¹ In addition, we could consider a concept of external support. A coalition form can be called externally supported if all players outside the coalition support the coalition form. If a coalition form is not externally supported, players outside a coalition have an incentive to engage in alternative coalitions with members inside the current coalition.

¹² See Engwerda et al. (2002) for a similar simulation set up.

¹³ The parameters \mathbf{k} and \mathbf{l} of the money demand functions become only important in case monetary targeting policies would be implemented by the ECB.